

On the choosing of the sample points for determine the External Q and Resonant Frequency of waveguide loaded cavities

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To determine the external Q and resonant frequency of waveguide loaded cavities via Kroll-Yu method^[1], four sample points on the ω - ϕ curve must be provided. From our experience, these four sample points should be carefully chosen in order to get the correct results. For coupling with High Q external, these points must be very closed to the resonant frequency. Examples are given below.

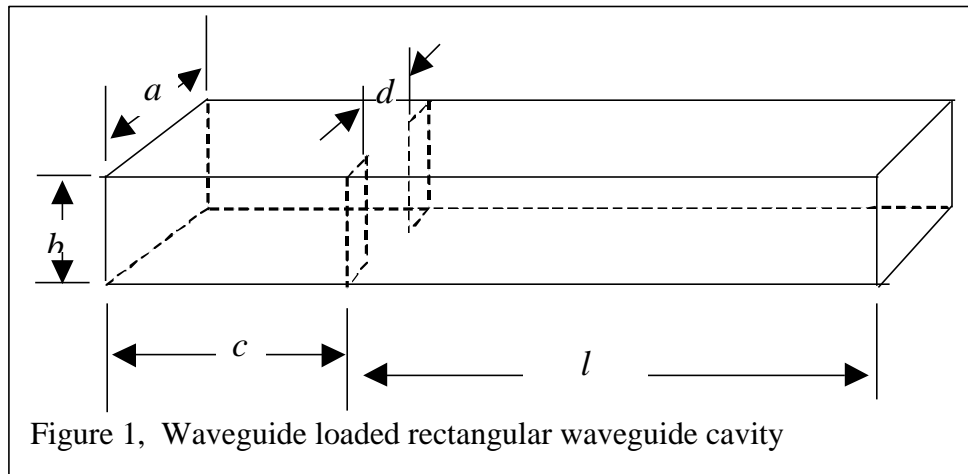


Figure 1, Waveguide loaded rectangular waveguide cavity

As shown in figure 1, the examples we chose here are rectangular waveguide cavities coupling to a rectangular waveguide with an iris. The reason for this choice is that such models have analytical solutions to compare.

Low external Q

For low external Q cavities, table 1 shows the relation of external Q and resonant frequency varying with the choosing of sample points. For the cavity here, $c=a$ and $d=0.75a$.

| u exact | u | Q exact | Q | Fr's |
|---------|---------|---------|---------|---------------------|
| 0.86632 | 0.86625 | 5.56898 | 5.56845 | 0.85,0.86,0.87,0.88 |
| 0.86632 | 0.86748 | 5.56898 | 5.58236 | 0.83,0.84,0.85,0.86 |
| | 0.86665 | | 5.56984 | 0.87,0.88,0.89,0.90 |
| | 0.86722 | | 5.56706 | 0.88,0.90,0.92,0.94 |
| | 0.86735 | | 5.56471 | 0.90,0.91,0.92,0.93 |

| | | | | |
|--|---------|--|---------|-----------------------|
| | 0.86631 | | 5.56890 | 0.86,0.865,0.87,0.875 |
|--|---------|--|---------|-----------------------|

From this table we see that for small external Q coupling, the more closer the sample points to resonant the better the results. But because the ϕ - ω curve is much smooth when the external Q is small, the error introduced by non-properly chosen sample points is small. So for the small external Q waveguide loaded cavities, it's not very critical about the choosing of the sample points.

High External Q

For High external Q example, the geometry is given as $c=a$ and $d=0.1a$. The table 2 here shows the resonant frequency and Q external changing with the selection of sample points.

| u exact | u | Q exact | Q | Fr's |
|---------|---------|---------|-------|----------------------|
| 0.99801 | 0.99801 | 20215 | 20287 | 0.97,0.98,0.99,0.995 |
| 0.99801 | 0.99658 | | 13223 | 0.96,0.98,1,1.02 |
| | 1.01422 | | 0.36 | 0.98,1,1.02,1.04 |
| | 0.99801 | | 20202 | 0.98,0.99,1,1.01 |
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From this table, we noticed that the sample points must be carefully chosen to be very close to the resonant point when the external Q is high enough. It's a critical requirement.

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| 1. | Norman M. Kroll and David U. L. Yu, "computer determination of the external Q and resonant frequency of waveguide loaded cavities", Particle accelerator, Vol. 34, p. 231-250, 1990 |
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